Ocean Research Report

EXPEDITIONS #5&#6
r/v Regina Maris

Silver, Navidad and Mouchoir Banks

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PRELIMINARY REPORT ON THE POPULATIONS OF HUMPBACK WHALES ON SILVER, NAVIDAD AND MOUCHOIR BANKS DURING THE WINTER 1977-1978

Cruise Report of
r/v REGINA MARIS EXPEDITIONS #5 and #6
Puerto Plata- Puerto Plata, Dominican Republic
12 December 1977- 20 April 1978

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SUMMARY

The populations of Humpback Whales on Silver, Navidad and Mouchoir Banks north of the Dominican Republic were censused from 26 November 1977 to nearly 15 April 1978 by visiting 9 stations - 7 on the banks, 2 off - at roughly 2 week intervals. Animals began to congregate on the Banks in mid-December and had largely departed by mid-April. The maximum population occurred in late February and was estimated at 2,300 whales, a total of the 3 banks. This estimate is thought to be on the high side because 2 of the Banks appear to be smaller than the charted areas used in these calculations.

INTRODUCTION

Populations of humpback whales (*Megaptera novaeangliae*) on Silver, Navidad and Mouchoir Banks have been assessed by Winn, Edel, and Taruski (1975), Balcomb and Nichols (1978), and an estimate for the entire Northwest Atlantic has been made by Mitchell (1973). Each of these investigators has only made census runs on the Banks during a comparatively short period (less than one month) during any year. We report here on the preliminary results of a study whose major purpose was to monitor the populations on the Banks throughout the period during which whales are seen there. In the course of the winter 1977-1978, we made regular census runs on and near the Banks allowing population and density estimates to be computed. The only study providing comparable results on changes of density with time is that of Dawbin (1966) on the humpback population migrating past New Zealand.

METHODS

The research vessel, REGINA MARIS, a 44 metre barquentine, made eight standard two-week circuits of Silver, Navidad and Mouchoir Banks between 12 December 1977 and 20 April 1978. She was also present there between 23 and 29 November 1977, during which time no humpback whales were seen and no underwater sounds attributable to humpbacks were heard. A brief description of r/v REGINA MARIS and some of her facilities is given by Balcomb and Nichols (1978).

During each circuit approximately 150 nautical miles of census work were performed on the three Banks and in the nearby ocean. Mean ship speeds during the census runs for the circuits ranged between 4.5 and 5.9 knots. A sample track for circuit #8 is shown in Figure 1, and other circuits approximated this route. While censusing, r/v REGINA MARIS maintained course and speed as far as navigationally possible.

Two observers were aloft at all times, of whom at least one was a member of the permanent scientific crew (B. Anderson, M. Anderson, K.C. Balcomb, B. Baxter, K. Chu, and H. Whitehead). Observers watched one side of the ship each, recording all whales as they came abeam, numbers in groups, approximate sizes (adult, immature or calf), movements, and behaviours (such as breaching). The estimated time of passage abeam was made for animals seen ahead and/or astern, but not surfacing abeam. Other species of cetacea, birds, turtles and fish sighted were also recorded. The observers' eye heights were between 23 and 27 metres above water level during 73 of the 87 census runs. For those made in heavier weather, the heights of eye were generally lower (approximately 15 metres). Ranges when abeam were estimated by eye, but frequent calibrations were made: the ranges of buoys, whales and small boats were calculated by measuring the dip below the horizon, using a sextant at a known height.

At each half hour, an observer on deck logged the ship's position, heading, speed, the depth, wave height, the direction and width of the sunstreak, and the cloud cover. Changes in the course and speed were also noted.

Using the data from these runs, preliminary population and density estimates, with confidence intervals, were made based on the following assumptions:

(1) All whales within 1,750 metres of the ship's track were seen. Although some may have been missed in rougher conditions, this is a more conservative assumption than those used by other investigations.

(2) No whales were counted twice.

(3) The movements of the whales were random, relative to the ship's track (no curiosity, shyness, et cetera).

(4) The areas of the Banks are as calculated by Winn et al (1975) from United States Hydrographic Office charts.

(5) (Only needed for confidence intervals), Groups of whales are randomly and independently distributed on the Banks.

Density estimates (r) for runs totalling L kilometres, in which n whales were seen within 1,750 metres of the ship's track when abeam, were calculated from:

$$r = \frac{n}{2 \times 1.75 \times L} \quad \text{whales} \quad \text{km}^{-2}$$

Then the estimated population (N) on a Bank of area A km^2 is calculated from:

$$N = A \times r \quad \text{whales}$$

Approximate 95% confidence intervals for either density or population estimates are calculated from:

$$r \pm \frac{2 \times r \times k}{\sqrt{n}} \, , \quad N \pm \frac{2 \times N \times k}{\sqrt{n}}$$

Where k is a groupings factor:

$$k = \sqrt{\frac{\sum t^2 \times n_t}{\sum n_t}}$$

and n_t is the number of groups of size t.

RESULTS

Tables 1 to 3 give the distances travelled, the total numbers of whales and newborn calves sighted, the numbers sighted less than 1,750 metres from the ship's track, and the population estimates, density estimates and confidence intervals for the different Banks on the different circuits. Table 4 gives density estimates and confidence intervals for the parts of the runs made within 10 nautical miles of the Banks, but not on them. Figures 2 and 3 show the changes in population and density with time.

The whales were first seen in December. The populations then increased, peaked in late February or early March, and declined, at first rapidly and then more slowly, to roughly 10% of their peak values in late April. Comparatively few whales were seen on Mouchoir Bank or off the Banks. Young calves were first seen in early February.

DISCUSSION

The assumptions upon which this work is based have not yet been tested and, until further analysis has been performed, the estimates should be regarded as preliminary. We intend to use line transect methods, as described by Chapman, Eberhardt and Gilbert (1977), thereby eliminating the need for Assumption #1. Assumptions #2 and #3 are, we feel, reasonable, but will be tested using data collected on movements and ranges when abeam respectively. The Banks are certainly not shaped as charted and a more accurate chart is being made, based upon soundings aboard r/v REGINA MARIS during the winter, 1977-1978. The areas of Silver and Mouchoir Banks are smaller than given on US Hydrographic Office charts, which were used by Winn et al (1975), so that their population estimates, together with ours and those of Balcomb and Nichols (1978) are too high, by 5-30%.

The groups of whales are not randomly distributed on the Banks, some areas being consistently more densely covered (see also Balcomb and Nichols 1978), so that the confidence intervals should only be regarded as rough guidelines to the statistical errors. We intend to look more thoroughly into the fine structure of the distribution of the whales on the Banks, plotting density contours and obtaining population estimates by integration.

Although we regard these estimates as preliminary, they are based upon the same kind of methodology and assumptions as those of Winn et al (1975), Balcomb and Nichols (1978) and Mitchell (1973). However, as can be seen from Table 5, all their population estimates for Silver and Navidad Banks are considerably lower than ours for a similar time of year. Many of these variations are probably due to the differing widths of the strips either side of the ship's track in which it was assumed that all whales were seen.

Balcomb and Nichols (1978) made two possible estimates for each set of census runs, assuming that all whales within two nautical miles (3,710 m) and three nautical miles (5,560 m) were seen. Reworking their data with a strip width of 1,750 metres either side of the ship's track, the estimates are considerably higher, but they still saw significantly fewer groups of whales than we did (chi-squared = 10.0,8.4 for the two sets of runs on Silver Bank, $p < 0.005$ for both, see Table 6 and Figure 2). We are unable to tell whether this is because of additional differences in methodology between the studies of 1977 and 1978, or because there were more whales on Silver Bank in 1978, or because they migrated north earlier in the season in 1977.

It is possible that Mitchell's (1973) estimates of the Northwest Atlantic population may have suffered from the patchy distribution of the whales: Mitchell saw fewer humpbacks (103) in 3 years of census work in the North Atlantic than we counted during one morning on Navidad (181).

The effective strip width of 1.5 nautical miles (2,780 m) either side of the ship's track used by Winn et al (1975) seems too wide to justify the assumption that all whales within the strip were seen. They used boat speeds of 8.6 knots, which, together with the dive times of individual humpbacks which ranged in our observations between 1 and 25 minutes, suggest that Winn et al (1975) may well have missed whales which were under water while in their sighting area. Doi (1974) has investigated this problem and using his equations, we calculate that Winn et al (1975) will have undercensused whales diving for 20 minutes by 45%, those diving for 15 minutes by 35%, and those diving for 10 minutes by 22%. The problem of not counting whales which are underwater in the sighting area is reduced in our study by the lower ship speeds, higher elevations of the observers, and wider visual arcs (360 degrees rather than 60). Until a good statistical sample of the dive times of humpbacks on the Banks is obtained, allowing the exact rates of undercensusing to be calculated, conclusions drawn from comparisons between our estimates and those of Winn et al (1975) should be withheld.

The whale density on Navidad increased more quickly and started decreasing sooner than on Silver Bank. However, during March and early April, it stayed fairly constant while the whales on Silver were leaving. The most likely explanation for these density variations that we have found is that Silver and Navidad contain different proportions of different age and sex classes of the population. Dawbin (1966) has shown that different segments of the humpback population have different mean passage times past New Zealand (pregnant females migrate south first, followed by immatures, then mature males and finally lactating females). As evidence for this segregation, we saw 19 newborn calves on Silver, but only one on Navidad. Furthermore, humpback songs heard three days apart on Silver and Navidad were as similar as two songs heard on the same day on Silver, and more similar than songs heard one month apart on Silver (T. Dunlap and J. Swartz, students' report, r/v REGINA MARIS, Cruise #7), suggesting that the whales on the two Banks come from the same basic stock.

FURTHER RESEARCH

H. Whitehead will use more sophisticated methods to analyse these data so that population and density estimates will be based upon fewer and more tested assumptions. The data on densities, groupings, movements, and visible behaviours are being analysed for change with time of year, time of day, differences between Banks and within Banks. Possible correlations with environmental parameters such as wave height, depth and zooplankton density are being examined. During this study regular plankton tows were conducted by K. Chu and are presently under analysis. Photographs of humpback fluke patterns and other individually identifiable marks are being processed by B. Baxter at the College of the Atlantic, Bar Harbour, Maine, USA (see Katona, Baxter, Brazier, Kraus, Perkins and Whitehead, 1979). The recordings of humpback songs will be analysed by K. and R. Payne.

ACKNOWLEDGEMENTS

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Table 1. Census runs on Silver Bank.

Date Range	Distance Travelled	Total Whales Sighted	Whales Sighted <1750 m	Population Estimate	95% Confidence Interval	Density Estimate	95% Confidence Interval	Calves Sighted
12-19 Dec.	72.9 N.M.	2	0	0	0-25	0	0-.01	0
1-7 Jan.	65.5	42	18	123	53-193	0.0424	.02-.07	0
15-25 Jan.	95.5	230	179	839	649-1031	0.2892	.22-.36	0
31 Jan.- 5 Feb.	71.4	351	260	1,631	1321-1940	0.5618	.46-.67	2
7-15 March	87.4	510	394	2,019	1685-2353	0.6955	.58-.81	4
21-26 March	56.2	176	144	1,148	849-1446	0.3953	.29-.50	7
3-7 April	63.3	48	34	241	131-350	0.0829	.05-.12	1
15-19 April	60.8	33	19	140	60-220	0.0482	.02-.08	5

Table 2. Census runs on Navidad Bank.

Date Range	Distance Travelled	Total Whales Sighted	Whales Sighted <1750 m	Population Estimate	95% Confidence Interval	Density Estimate	95% Confidence Interval	Calves Sighted
16 Dec.	12.5 N.M.	0	0	0	0-27	0	0-.05	0
4 Jan.	19.0	22	20	86	39-132	0.1624	.07-.25	0
22 Jan.	25.0	86	64	209	129-288	0.3949	.24-.55	0
3-12 Feb.	36.5	263	202	451	356-546	0.8538	.67-1.03	0
6 March	12.6	33	30	194	66-321	0.3673	.13-.61	0
24 March	18.0	35	30	136	60-211	0.2571	.11-.40	0
5 April	19.6	48	44	183	104-262	0.3463	.20-.50	0
18 April	18.8	17	14	61	11-111	0.1149	.02-.21	1

Table 3. Census runs on Mouchoir Bank.

Date Range	Distance Travelled	Total Whales Sighted	Whales Sighted <1750 m	Population Estimate	95% Confidence Interval	Density Estimate	95% Confidence Interval	Calves Sighted
20-21 Dec.	31.4 N.M.	2	0	0	0-19	0	0-.02	0
8-10 Jan.	23.0	0	0	0	0-22	0	0-.02	0
6 Feb.	3.9	3	0	0	0-168	0	0-.17	0
10-11 March	24.4	27	20	122	50-194	0.1265	.05-.20	1
28 March	7.8	0	0	0	0-86	0	0-.09	0
2 April	26.6	4	4	22	0-57	0.0232	0-.05	0
15-19 April	27.0	2	1	6	0-20	0.0057	0-.02	0

Table 4. Census runs off the Banks.

Date Range	Distance Travelled	Total Whales Sighted	Whales Sighted <1750 m	Density Estimate	95% Confidence Interval	Calves Sighted
12-21 Dec.	45.9 N.M.	0	0	0	0-.02	0
1-10 Jan.	39.9	0	0	0	0-.02	0
15-25 Jan.	28.0	5	0	0	0-.02	0
31 Jan.- 12 Feb.	44.3	28	26	0.0905	.04-.14	0
6-16 March	93.8	52	41	0.0674	.05-.08	1
21-28 March	31.2	4	3	0.0148	0-.04	0
2-7 April	37.4	0	0	0	0-.02	0
15-20 April	44.8	1	0	0	0-.02	0

Table 5. Population estimates of humpback whales in the western North Atlantic.

Investigator	Time Period	Area Censused	Visual arc	Strip Width	Population Estimate	Comparable Estimate from this Study
Balcomb and Nichols (1978)	9-12 March 1977	Silver Bank	120°	6 N.M. (11120 m) 4 N.M. (7410 m) 3500 m. *	565 809 1561	2019
	21-27 March 1977	Silver Bank	120°	6 N.M. (11120 m) 4 N.M. (7410 m) 3500 m. *	407 544 621	1148
	7 March 1977	Navidad Bank	120°	4 N.M. (7410 m)	100	194
	29 March 1977	Mouchoir Bank	120°	4 N.M. (7410 m)	25	0
Winn et. al. (1975)		Silver Bank	60°	3 N.M. (5560 m)	754	1631
	2-19 February 1973	Navidad Bank	60°	3 N.M. (5560 m)	110	451
		Mouchoir Bank	60°	3 N.M. (5560 m)	18	0
Mitchell (1973)	Spring and Summer 1966-1969	Northwest Atlantic	?	8 N.M. (14830 m)	1259	>2213

* - Original data reanalysed by present investigators.

Table 6. Comparisons between sightings of groups of whales on Silver Bank by Balcomb and Nichols (1978) and during 1977-1978 study.

Groups of whales seen less than 1750 metres from the ship's track:

	Early March		Late March	
	Groups seen	N.M. Travelled	Groups seen	N.M. Travelled
1977	83	39.0	31	30.3
1978	276	87.4	103	56.2

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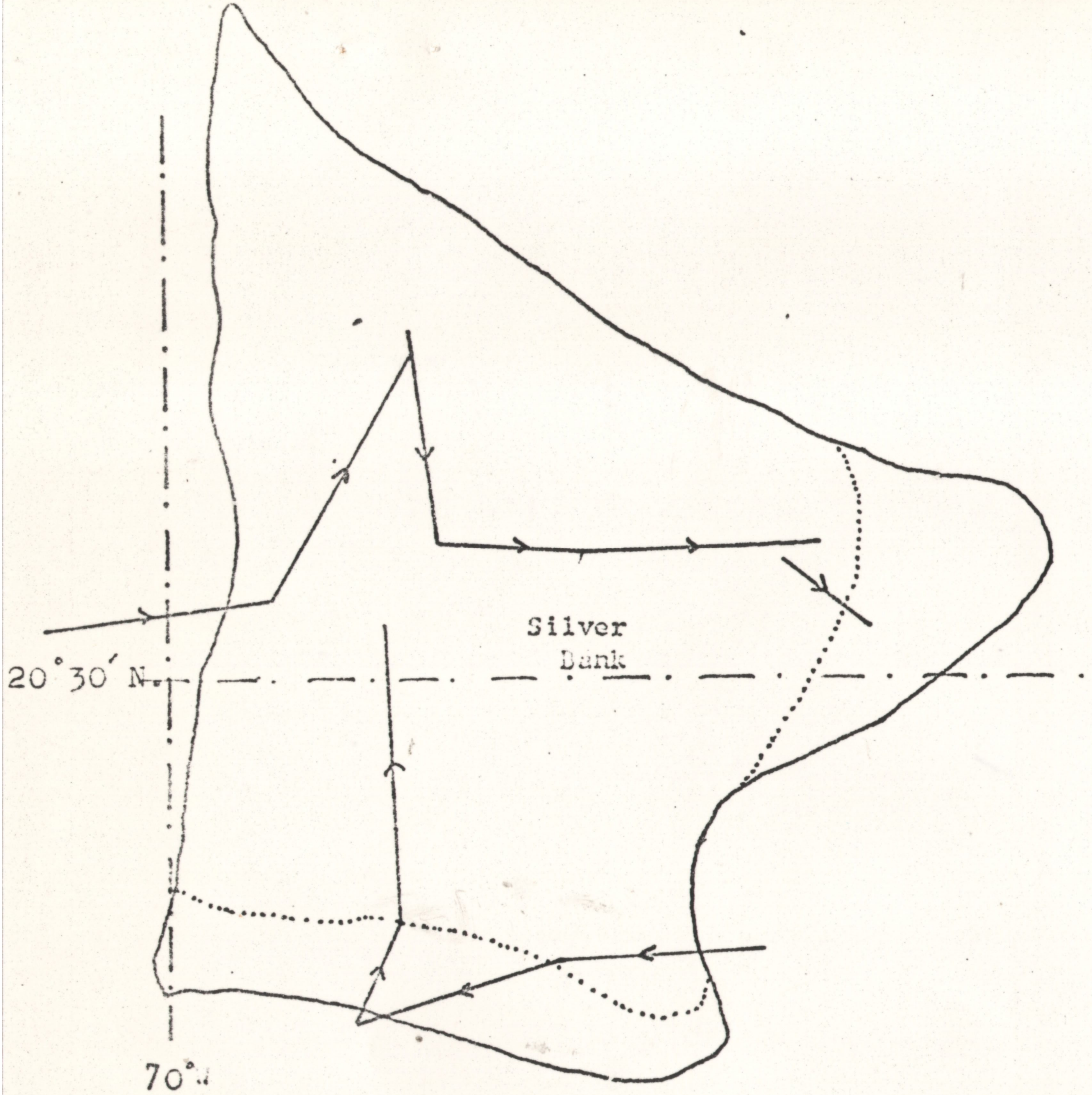

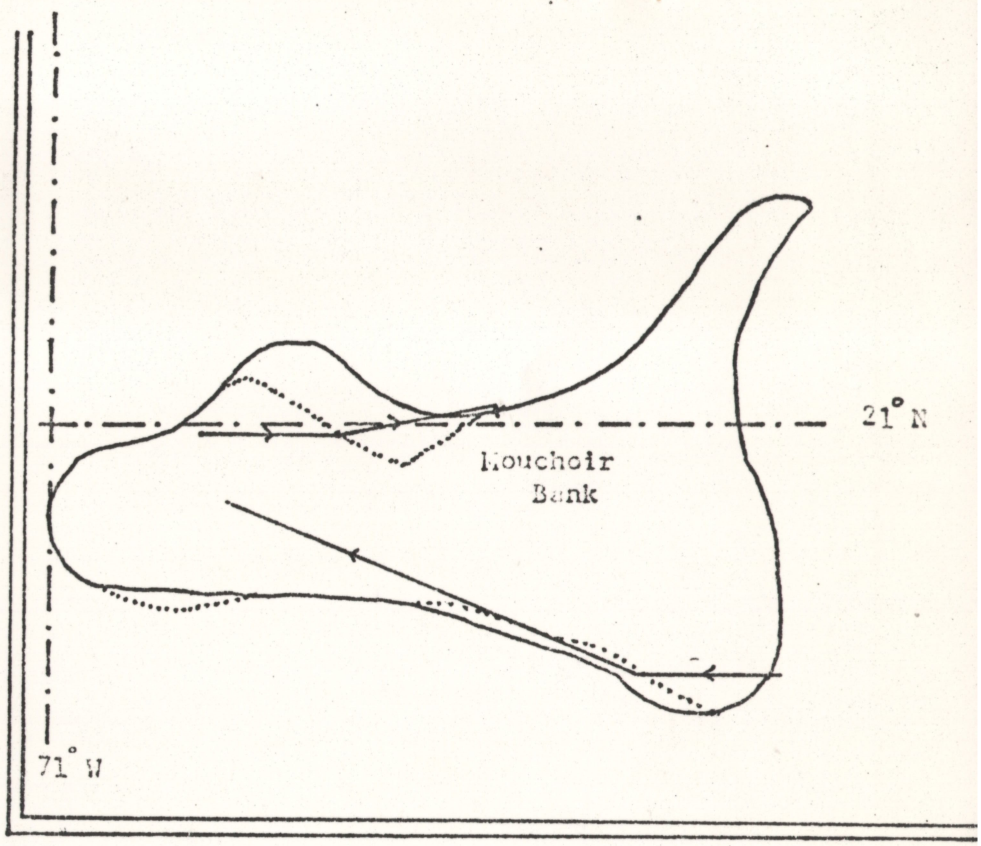

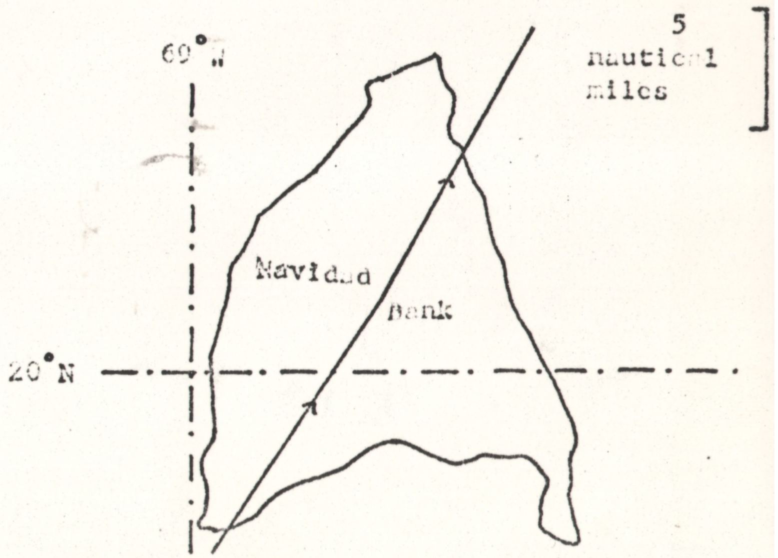

Figure 1. Census runs April 15-20, 1970.

⁓ Charted Bank edge

.... Approximate true Bank edge

—→— Census runs

Figure 2. Humpback whale population estimates for Silver, Navidad, and Mouchoir Banks during the winter 1977-1978.

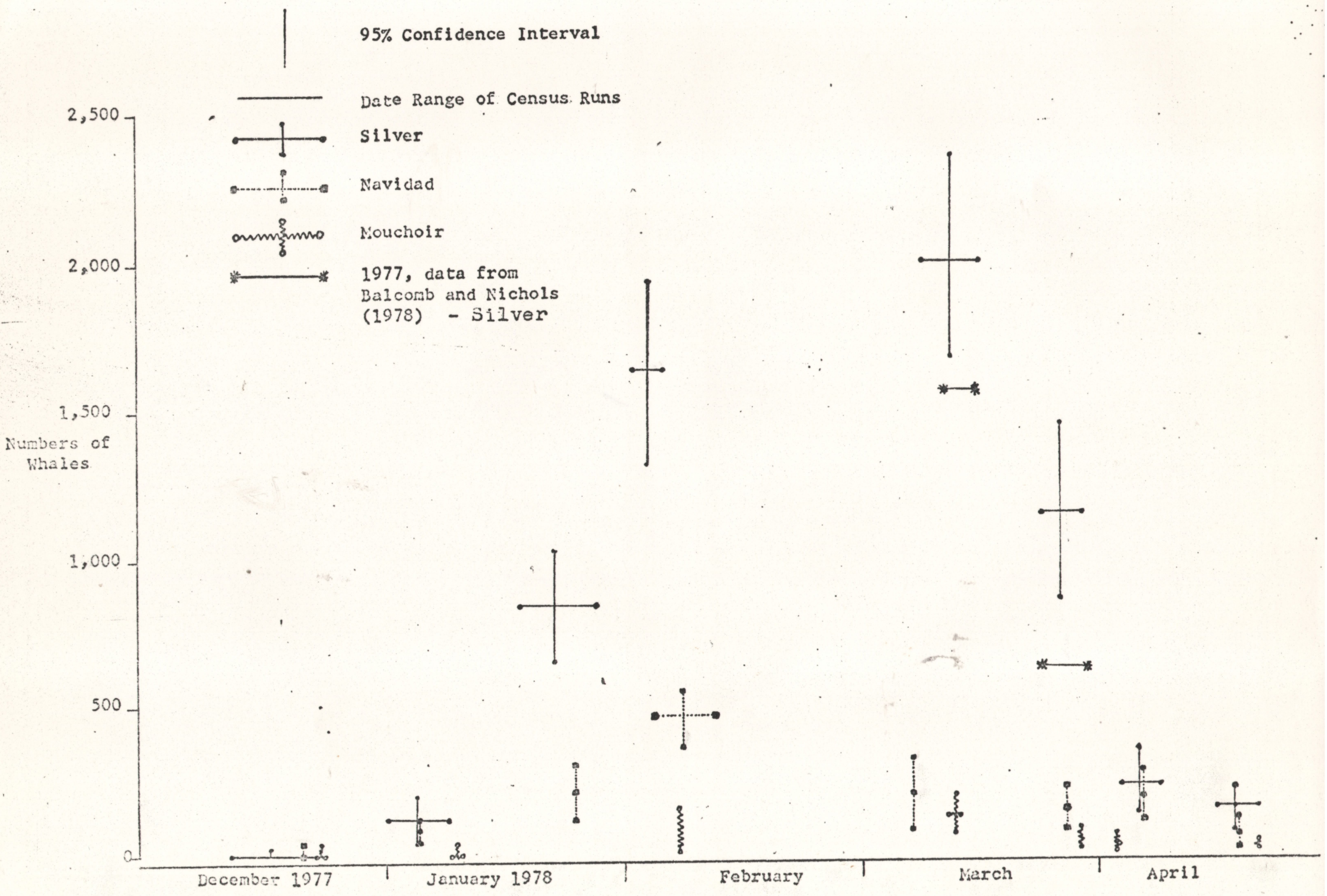

Figure 3. Humpback whale density estimates for Silver, Navidad, and Mouchoir Banks, and surrounding ocean areas during the winter 1977-1978. Densities in Whales.km^{-2}.